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ABSTRACT:

A colored contact lens having a very natural appearance is disclosed. The inventive lens has a non-opaque pupil section and iris section that is at least partially opaque and comprised of two portions. A first portion, generally located on the outside of the iris section, has a first shade. A second portion, generally located on the inside of the iris section has a second shade. A jagged border separates the two portions. A third iris section and second jagged border are also disclosed. In some embodiments portions of the iris section may be non-opaque.

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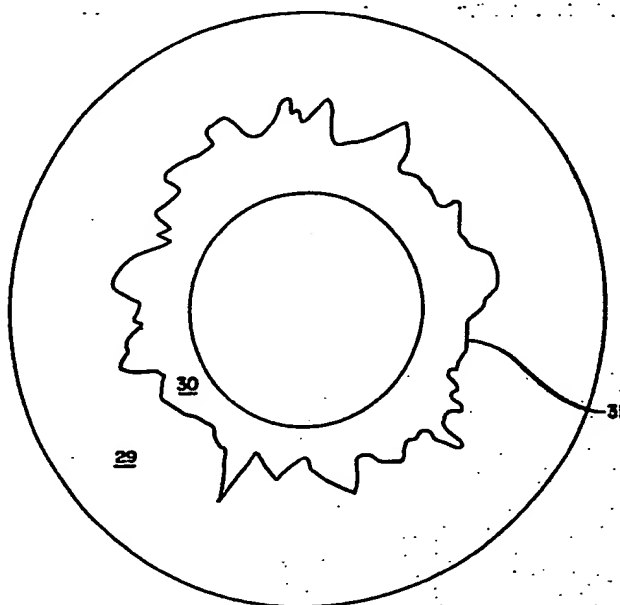
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(54) Title: COLORED CONTACT LENS HAVING VERY NATURAL APPEARANCE



(57) Abstract

A colored contact lens having a very natural appearance is disclosed. The inventive lens has a non-opaque pupil section and iris section that is at least partially opaque and comprised of two portions. A first portion, generally located on the outside of the iris section, has a first shade. A second portion, generally located on the inside of the iris section has a second shade. A jagged border separates the two portions. A third iris section and second jagged border are also disclosed. In some embodiments portions of the iris section may be non-opaque.

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COLORED CONTACT LENS HAVING
VERY NATURAL APPEARANCE

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The present invention relates to colored contact lenses and in particular to such lenses having opaque colored portions that are able to change the apparent color of the wearer's iris while imparting a very natural appearance.

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It was recognized very early that a contact lens with opaque coloring should not have a simple solidly colored iris. Such a lens imparts a very unnatural appearance. Wichterle in U.S. Patent No. 3,679,504 discloses an opaque lens having an iris of more than a single color that is artistically drawn or photographically reproduced. Such a lens never achieved commercial success. Other attempts to produce an opaque lens with a natural appearance are disclosed in U.S. Patents No. 3,536,386, (Spivak); 3,712,718 (LeGrand), 4,460,523 (Neefe), 4,719,657 (Bawa), 4,744,647 (Meshel et al.), 4,634,449 (Jenkins); European Patent Publication No. 0 309 154 (Allergan) and U.K. Patent Application No. 2 202 540 A (IGEL).

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Knapp (in U.S. Patent No. 4,582,402) discloses a contact lens having, in its preferred embodiment, colored, opaque dots. The Knapp lens has been an enormous commercial success. A natural appearance is achieved, yet the lens is simple and inexpensive to produce, using a simple one-color printed dot pattern. At Column 3, lines 23 to 29, Knapp discloses that "For a more natural effect, the printing step

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may be repeated one or more times using different patterns in different colors, since upon close examination the iris's of many persons are found to contain more than one color. The printed pattern need not be absolutely uniform, allowing for
5 enhancement of the fine structure of the iris." The one-color Knapp lenses currently achieving commercial success have their dots arranged in an irregular pattern to enhance the structure of the iris. However, neither the Knapp commercial lenses, nor the Knapp patent disclose or suggest how one would
10 arrange a pattern of dots having more than one color to achieve a more natural appearance.

The present invention is predicated on the surprising discovery that very simple multiple-color opaque
15 patterns (some of them in accordance with the Knapp disclosure) achieve an amazingly naturally appearing iris. The improvement in appearance over the one-color Knapp lenses, currently achieving enormous commercial success, is startling. Like the one color lenses, the lenses of this
20 invention are able to cause a fundamental change in the apparent color of the wearer's iris, e.g. from dark brown to light blue or green. Although the preferred embodiments of the invention are two-color lenses, use of more than two colors is contemplated.

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SUMMARY OF THE INVENTION

One aspect of the invention comprises a colored contact lens comprising a non-opaque pupil section, an iris
30 section surrounding said pupil section, and a colored, opaque intermittent pattern over said entire iris section, that leaves a substantial portion within the interstices of the pattern non-opaque, said pattern covering at least about 25 percent of the area of said iris section, the elements of said pattern

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being undiscernible to the ordinary viewer, wherein a first portion of the elements of said pattern are of a first shade and a second portion of the elements of said pattern are of a second shade different from said first shade, wherein said

5 first portion is located generally on the outside of said iris section and said second portion is located generally on the inside of said iris section, and a jagged border separates said first and second portions, wherein the minimum distance of said jagged border from the outer perimeter of said iris

10 section is from about 5% to about 45% of the radial width of said iris section, and the maximum distance of said border from the outer perimeter of said iris section is from about 45% to about 95% of the radial width of said iris section, thereby providing a lens capable of changing the apparent color

15 of the iris of a person wearing the lens and imparting a very natural appearance.

A second aspect of the invention comprises a colored contact lens comprising a non-opaque pupil section, an

20 opaque iris section surrounding said pupil section except for non-opaque elements in said iris section undiscernible to the ordinary viewer, wherein a first portion of said opaque iris section is of a first shade, and a second portion of said opaque iris section is of a second shade different from said first

25 shade, said first portion is located generally on the outside of said iris section and said second portion is located generally on the inside of said iris section, and a jagged border separates said first and second portions, wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 5% to about 45% of the radial

30 width of said iris section, and the maximum distance of said border from the outer p rimeter of said iris section is from about 45% to about 95% of the radial width of said iris section, thereby providing a lens capable of changing the

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apparent color of the iris of a person wearing the lens and imparting a natural appearance.

A third aspect of the invention comprises a colored
5 contact lens comprising a non-opaque pupil section and an
opaque iris section surrounding said pupil section, wherein a
first portion of said iris section is of a first shade, and a
second portion of said iris section is of a second shade
different from said first shade, said first portion is located
10 generally on the outside of said iris section and said second
portion is located generally on the inside of said iris section
and a jagged border separates said first and second portions,
wherein the minimum distance of said jagged border from the
outer perimeter of said iris section is from about 5% to about
15 45% of the radial width of said iris section, and the maximum
distance of said border from the outer perimeter of said iris
section is from about 45% to about 95% of the radial width of
said iris section, thereby providing a lens capable of changing
the apparent color of the iris of a person wearing the lens and
20 imparting a natural appearance.

A fourth aspect of the invention comprises a
colored contact lens comprising a non-opaque pupil section and
an iris section surrounding said pupil section, said iris section
25 comprising a first outer portion and a second inner portion
separated by a jagged border wherein the minimum distance of
said jagged border from the outer perimeter of said iris
section is from about 5% to about 45% of the radial width of
said iris section and the maximum distance of said border
30 from the outer perimeter of said iris section is from about
45% to about 95% of the radial width of said iris section,
wherein one of said sections is non-opaque and the other
section has opaque coloring.

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A fifth aspect of the invention comprises a colored contact lens comprising a non-opaque pupil section and an iris section surrounding said pupil section, said iris section comprising a first outer portion surrounding a second intermediate portion and a third inner portion surrounded by said intermediate portion, said first and second portions separated by a first jagged border and said second and third portions separated by a second jagged border, wherein either said first and third portions have opaque coloring and said second portion is non-opaque, or said second portion has opaque coloring and said first and third portions are non-opaque, or said first, second and third portions have opaque coloring and said second portion has a different shade than said first and second portions.

Preferably, in the first aspect of this invention, the elements of the pattern are opaque dots, and the following color combinations are used:

FIRST (OUTER) PORTION

Green
Blue
Brown
Blue

SECOND (INNER) PORTION

Hazel
Hazel
Hazel
Gray

The most preferable dot patterns are as shown in Figures 1 to 6.

The term "non-opaque" as used herein is intended to describe a part of the lens that is uncolored or colored with translucent coloring.

The term "second shade different from said first shade" as used herein is intended to mean that both shades are

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of totally different colors, such as blue and hazel; or that both shades are the same basic color, but having different intensities such as light blue and dark blue.

5 The term "ordinary viewer" is intended to mean a person having normal 20-20 vision standing about 5 feet from a person wearing the lenses of this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figure 1 illustrates a dot pattern very close to the one-color dot pattern of the Knapp lenses currently being sold. As shown below, this pattern may be overprinted to form a lens in accordance with the present invention.

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Figure 2 illustrates a preferred dot pattern of an inside portion of dots in accordance with the invention.

20 Figure 3 illustrates a preferred dot pattern of an outside portion of dots in accordance with the invention.

Figure 4 illustrates a alternative dot pattern for an outside portion of dots in accordance with the invention.

25 Figure 5 illustrates an alternative dot pattern for an inside portion of dots in accordance with the invention.

Figure 6 illustrates a dot pattern for overprinting lenses in accordance with the invention with a third color.

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Figures 7 and 8 illustrate alternative embodiments of iris patterns in accordance with the second and third aspects of the invention, respectively.

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Figures 9 and 10 illustrate further alternative embodiments of iris patterns in accordance with the fourth and fifth aspects of the invention, respectively.

5 DETAILED DESCRIPTION OF THE INVENTION

 Contact lenses in accordance with the preferred
embodiments of this invention are also in accordance with
those disclosed in Knapp's U.S. Patent No. 4,582,402. Such a
10 prior art lens is illustrated in Figure 1. It has a non-opaque
 pupil section 20 in the center of lens, and an annular iris
 section 21 surrounding the pupil section. For hydrophilic
 lenses peripheral section 22 surrounds iris section 21. A
 colored, opaque, intermittent pattern is located over the entire
15 iris section 21, as show in Figure 1. The pattern leaves a
 substantial portion of the iris section within the interstices
 of the pattern non-opaque. The non-opaque areas of iris
 section 21 appear white in figure 1.

20 The elements of the pattern are preferably dots,
 and especially preferred are dots, some of which run together,
 as shown in Figure 1. Certain portions of the iris section 21
 are less densely covered with dots than other portions. The
 less densely covered portions form approximately radial
25 spokes. This arrangement enhances the structure of the iris of
 a person wearing the lens.

 Of course, the opaque pattern may be comprised of
dots having any shape, regular or irregular, such as round,
30 square, hexagonal, elongated, etc. Furthermore, the elements
 of the pattern may have a shape other than dots, so long as the
 elements are undescrinable to the ordinary viewer, cover at
 least about 25 percent of the iris, and leave a substantial

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portion of the iris section within the interstices of the pattern non-opaque.

Thus far, this description has covered the Knapp invention of U.S. Patent No. 4,582,402 and lenses in accordance thereof which have been sold commercially since about November, 1986. The one-color commercial lenses have a pattern that is almost exactly like that of Figure 1, except that the commercial lenses have a smaller pupil section and a wider iris section caused by about two extra rows of dots on the periphery of pupil section 20. That is, the two extra rows of dots, actually present in the commercial lenses, are not shown in Figure 1.

The improvement of this invention is a very simple multiple-color pattern that greatly improves the natural appearance of the wearer's iris, even over that of the one-color lens currently achieving much commercial success. To produce this two-color pattern of this invention, the elements of the pattern (preferably dots) are in two portions. A first portion of the elements are of a first shade and are located generally on the outside of the iris section, i.e. at or near the outer perimeter of the annular iris section. A preferable first outside portion pattern is shown in Figure 3. A second portion of the elements are of a second shade different from the first shade and are located generally on the inside of the iris section, i.e. at or near the inner perimeter of the annular iris section and surrounded by the first outside portion. A preferable second inside portion pattern appears in Figure 2. A jagged border separates the inner and outer portions of the pattern elements. This border need not be precise. Some dots of the first shade may be mixed in with dots of the second shade, so long as there is a jagged border or border zone across which there takes place a noticeable change of shade. If the

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patterns of figures 2 and 3 are merged to form a two-color lens, the jagged outer edge of the pattern of Figure 2 will merge with the jagged inner edge of the pattern of Figure 3 to form the required jagged border between the two portions
5 having different shades.

Producing the opaque portions of the iris section is preferably accomplished by printing the lens twice using the known printing process of Knapp's U.S. Patent No. 4,582,402,
10 incorporated herein by reference. Very briefly, a plate or cliché having depressions in the desired pattern is smeared with ink of the desired shade. Excess ink is removed by scrapping the surface of the plate with a doctor blade leaving the depression filled with ink. A silicon rubber pad is pressed
15 against the plate to pick up the ink from the depressions and then is pressed against a surface of the lens to transfer the pattern to the lens. The printed pattern is then cured to render it unremovable from the lens. Of course, either the anterior or posterior surfaces of the lens may be printed, but printing the
20 anterior surface is presently preferred.

The preferred lenses and inks used to practice this invention are known and described in Loshak's U.S. Patent No. 4,668,240, incorporated herein by reference. Very briefly, a
25 lens constructed of polymer having $-COOH$, $-OH$, or $-NH_2$ groups is printed with ink containing binding polymer having the same functional groups, opaque coloring substance, and a diisocyanate compound. First a solution of binding polymer and solvent is prepared and this solution is mixed with paste
30 containing the coloring substance to form an ink. The preferred binding polymer solutions described in the Loshak patent have a viscosity of 25,000 CPS. It is currently preferred to form inks for the present lenses from binding

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polymer solutions having a viscosity of about 40,000 CPS. The opaque ink is printed and cured on the lens surface.

Of course, alternative ways to form colored opaque elements of the lens may be used. For example, selected portions of the iris section of a wetted hydrophilic lens may be impregnated with a solution of a first substance, such as barium chloride. Then the lens may be immersed in a solution of a second substance, such as sulfuric acid, that forms an opaque, water-insoluble precipitate with the first substance, for example barium sulfate. Thus an opaque precipitate forms within the lens in a predetermined pattern in the iris section. Next all or at least the opaque pattern of the iris section is colored with translucent tint in two colors in accordance with this invention. This provides a lens having a colored opaque pattern in accordance with the invention. If the entire iris is colored with translucent tint, then the interstices within the pattern will be translucently colored, but still non-opaque and in accordance with the first or second aspects of the present invention. Optionally, the pupil section of the lens may be colored by a non-opaque tint, because such tint is not visible when the lens is against the dark pupil present in the eye of the wearer. Other alternative opaquing methods include use of a laser (U.S. Patent No. 4,744,647) and finely ground particles U.S. Patent No. 4,460,523.

The following examples illustrate preferred embodiments, but in general, the exact opaque pattern, and the methods of achieving opacity and coloring are not critical to practice of the invention.

In the following examples, all dimensions are for unhydrated hydrophilic lenses. Upon hydration, the lenses expand by a factor of about 1.3 times their unhydrated size.

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Hence, upon hydration, all dimensions will be about 1.3 times the values that follow. However, the calculated distances of the jagged border from the outer perimeter of the iris section as a percent of the radial width of the iris section will not
5 change upon hydration.

Although preferred lenses of this invention expand by a factor of about 1.3 upon hydration, those skilled in the art will recognize that different lenses having different amounts
10 of expansion upon hydration may also be used.

EXAMPLE 1

A hydrophilic lens made of hydroxyethyl
15 methacrylate, ethoxy ethyl methacrylate, and methacrylic acid as shown in U.S. Patent No. 4,668,240 is printed on its front, convex side with ink of a first shade containing pigment, binding polymer made from the same monomers used to form the lens, hexamethylene diisocyanate and solvent. The printed
20 pattern is shown in Figure 1. It covers most of the iris section, having an annular form, with an outer radius R^1 of about 5.2 mm and an inner radius R^2 of about 2.2 mm. After the ink has cured, the first pattern is overprinted with the pattern shown in Figure 2 having a different shade than the
25 pattern of Figure 1. To accomplish this second printing, it is highly preferable to have the centers 23 of the patterns overlap. However, it is not necessary to rotationally align the patterns of Figures 1 and 2. That is, after the figure 1 pattern is printed on the lens, the rotation of the lens or the pad used
30 in printing the pattern of figure 2 about lens center 23 is not important. An attractive lens is produced regardless of this rotation.

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The lens pattern of Figure 2 has an inner radius R^3 of about 2 mm and a variable outer radius having a maximum of about 4.5 mm at 24 and a minimum of about 2.7 mm at 25.

Variations in the outer radius create the jagged outer edge of the Figure 2 pattern. Notice that since the Figure 1 pattern has a radius R^1 of 5.2mm, the outer pattern extends inward, into the iris section distances of about 5.2 - 4.5 or 0.7 mm (minimum) to about 5.2 - 2.7 or 2.5 mm (maximum).

10 The radial width of the iris section is outer radius R^1 minus inner radius R^3 or 5.2 mm - 2 mm = 3.2 mm. Hence, it can be seen that the distance of the jagged border from the outer perimeter of the iris section ranges from a minimum of 0.7/3.2 or about 20% of the radial width of the iris section to
15 a maximum of 2.5/3.2 or about 80% of the radial width of the iris section. In general, the minimum distance of the jagged border from the outer perimeter of the iris section should be from about 5% to about 45% (more preferably about 10% to about 30%) of the radial width of the iris section and the
20 maximum distance of the jagged border from the outer perimeter should be from about 45% to about 95% (more preferably about 60% to about 80%) of the radial width. Hence, the outer pattern comprises a substantial portion of the area of the iris and is not merely a thin outer ring at the periphery as described, for example, in U.S. Patent No. 4,719,657, (Bawa)
25 col. 7, line 56 to Col. 8, line 34. The finished lens of this example will have the Figure 1 pattern overprinted by the Figure 2 pattern and will thus have an outer portion comprised solely of elements of the first shade of Figure 1 and an inner
30 portion comprised primarily of the second shade of Figure 2, but with some of the Figure 1 shade showing through the interstices of the Figure 2 pattern.

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Although the exact shades used in practicing the invention are not critical, the shades produced by the Inks shown in the table below are presently preferred.

5

PIGMENT WT % IN INK

| <u>INK NO.</u> | <u>NOMINAL COLOR</u> | <u>TiO₂</u> | <u>FeO (Red)</u> | <u>FeO (Blk)</u> | <u>FeO (Yel)</u> | <u>Cr₂O₃</u> | <u>PCN BLUE</u> |
|----------------|--------------------------|------------------------|------------------|------------------|------------------|------------------------------------|---------------------|
| 1 | Blue | 5.3 | 0 | 0 | 0 | 0 | 0.6 |
| 2 | Hazel | 0.7 | 1.9 | 0 | 5.3 | 0 | 0.1 |
| 3 | Green | 0.0 | 0 | 0 | 0 | 12.2 | 0 |
| 4 | Brown | 0.0 | 5.3 | 8.7 | 0 | 8.8 | 0 |
| 5 | Yellow | | | | | | |
| | Brown | 0.3 | 0.8 | 0 | 4.6 | 0 | 0 |
| 6 | Misty Gray | 4.2 | 0 | 1.1 | 0 | 0 | 0 |
| 7 | Dark Gray | 4.3 | 0 | 7.1 | 0 | 0 | 0 |
| 8 | Black | 0.0 | 0 | 14.6 | 0 | 0 | 0 |

In the above table, the following abbreviations are used:

- 10 TiO₂ Titanium Dioxide
 FeO (Red) Red Iron Oxide
 FeO (Blk) Black Iron Oxide
 FeO (Yel) Yellow Iron Oxide
 Cr₂O₃ Chromium Sesquioxide
 15 PCN Blue Phthalocyanine blue (Pigment Blue 15, C.I.74160)

In addition to the pigments, the inks contain binder polymer, solvent, and di- or higher isocyanate compound as described in Loshaek's U.S. Patent No. 4,668,240. The following specific

- 20 color combinations are currently preferred:

| <u>EXAMPLE</u> | <u>FIG. 1 PATTERN</u> | <u>FIG. 2 PATTERN</u> |
|----------------|-----------------------|-----------------------------|
| 1A | Ink No. 3 (Green) | Ink No. 2 (Hazel) |
| 1B | Ink No. 1 (Blue) | Ink No. 2 (Hazel) |
| 1C | Ink No. 4 (Brown) | Ink No. 5 (Yellow Brown) |
| 1D | Ink No. 1 (Blue) | Ink No. 6 (Gray) |

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EXAMPLE 2

A contact lens is printed first with the pattern of Figure 3 and then with the pattern of Figure 2 in a second shade. When using these two patterns, centers 23 of both patterns are in alignment and in addition the patterns are rotationally aligned so that radial lines RL¹ and RL² coincide. The following color combinations are currently preferred:

| <u>EXAMPLE</u> | <u>FIG. 3 PATTERN</u> | <u>FIG. 2 PATTERN</u> |
|----------------|------------------------|--------------------------|
| 2A | Ink No. 1 (Blue) | Ink No. 2 (Hazel) |
| 2B | Ink No. 3 (Green) | Ink No. 2 (Hazel) |
| 2C | Ink No. 4 (Brown) | Ink No. 5 (Yellow Brown) |
| 2D | Ink No. 1 (Blue) | Ink No. 6 (Misty Gray) |
| 2E | Ink No. 6 (Misty Gray) | Ink No. 7 (Dark Gray) |

10

EXAMPLE 3

Contact lenses are printed with the pattern of Figure 4, then with the pattern of Figure 5 in a second shade, and finally with the pattern of Figure 6 in a third shade. Centers 23 of each pattern are aligned and patterns 4 and 5 are rotationally aligned along radial lines RL³ and RL⁴. As seen in Figures 4 and 5, the jagged border between the portions of the iris sections having the first and second shades will be a minimum distance of about 10% of the radial width of the iris section from the outer perimeter of the iris section and a maximum distance of about 80% of the radial width. This border is very jagged and less distinct than the border of examples 1 and 2. The following color combinations are currently preferred:

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| <u>EXAMPLE</u> | <u>FIG. 4 PATTERN</u> | <u>FIG. 5 PATTERN</u> | <u>FIG. 6 PATTERN</u> |
|----------------|---------------------------|-----------------------------|---------------------------|
| 3A | Ink No. 3 (Green) | Ink No. 2 (Hazel) | Ink No. 8 (Black) |
| 3B | Ink No. 1 (Blue) | Ink No. 2 (Hazel) | Ink No. 8 (Black) |
| 3C | Ink No. 5 (Brown) | Ink No. 5 (Yellow Brown) | Ink No. 8 (Black) |
| 3D | Ink No. 1 (Blue) | Ink No. 6 (Gray) | Ink No. 8 (Black) |
| 3E | Ink No. 6 (Misty Gray) | Ink No. 7 (Dark Gray) | Ink No. 8 (Black) |

Example 3A to 3E illustrate three-color lenses.

5 All of the lenses in accordance with the above examples have a much more natural appearance than the one-color lenses in accordance with Knapp's U.S. Patent No, 4,582,402, currently achieving enormous commercial success.

10

EXAMPLE 4

Prepare a lens in accordance with the second aspect of this invention by using the patterns of Figure 7. In Figure 7, an opaque iris section 26 has non-opaque elements 27 (only a few of which are labeled). The non-opaque elements of figure 7 are roughly radially elongated areas and dots. The opaque area has a first section of a first shade and a second inner section of a second shade different from the first shade, separated by jagged border 28.

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EXAMPLE 5

Prepare a lens in accordance with the third aspect of the invention by using the patterns of Figure 8. The iris section of the lens is opaque. An outer section 29 has a first

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shade and an inner section 30 has a second shade. Jagged border 31 separates sections 29 and 30.

Although lenses in accordance with Examples 4 and 5 have not been produced, it is believed that they would achieve a far more natural appearance than the same lenses having a single color. Yet preparing lenses in accordance with these two embodiments is much more simple and much less expensive than attempting to reproduce a natural iris by photographic or artistic means as disclosed by Wichterle in U.S. Patent No. 3,679,504.

Figure 9 illustrates a lens in accordance with the fourth aspect of the invention wherein a substantial portion of the natural color of the wearer's iris may be visible. The lens of figure 9 comprises a non-opaque pupil section 40 and an iris section comprising a first outer portion 41 and a second inner portion 42. Iris portions 41 and 42 are separated by jagged border 43 having the same minimum and maximum distances from the outer perimeter 44 of the iris section as percentages of the radial width of the iris section as described previously. One of portions 41 or 42 is non-opaque and the other portion has opaque coloring. For example, inner portion 42 may have opaque coloring and outer portion 41 may be non-opaque, or vice versa. If the non-opaque portion is uncolored, or if the non-opaque portion is translucently colored and the wearer has iris's having dark-enough color to show through the non-opaque coloring, than a substantial portion of the natural color of the wearer's iris will be visible. For hydrophilic lenses, a non-opaque outer section 45 surrounds the iris section. Preferably, the opaque coloring is a pattern of elements not discernable to the ordinary viewer, but solid opaque color coloring or solid coloring with non-opaque elements could also be used.

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Figure 10 illustrates a lens accordance with the fifth aspect of the invention. This lens, like that of the lens of figure 9, also may allow a substantial portion of the natural color of the wearer's iris to be visible. The lens of figure 10 comprises a pupil section 50 and an iris section comprising a first outer portion 51 surrounding a second intermediate portion 52, and a third inner portion 53 surrounded by intermediate portion 52. Outer portion 51 and intermediate portion 52 are separated by a first jagged border 54. Intermediate portion 52 and inner portion 53 are separated by a second jagged border 55. For hydrophilic lenses, a non-opaque outer section 56 surrounds the iris section. In this embodiment of the invention, three different color schemes are contemplated.

15

A. Inner portion 53 and outer portion 51 have opaque coloring and intermediate portion 52 is non-opaque, or

B. Intermediate portion 52 has opaque coloring and inner portion 53 and outer portion 51 are non-opaque, or

20

C. All three portions 51, 52 and 53 have opaque coloring and intermediate portion 52 has a different shade than outer portion 51 and inner portion 53.

25

Preferably the opaque coloring is a pattern of elements undiscernable to the ordinary viewer, but, of course, other types of opaque coloring may be used.

30

When the lenses of figures 9 and 10 having a non-opaque section allow the wearer's natural iris color to be visible, identically colored lenses could cause very different appearances in different wearers, allowing very pleasing and varied color effects.

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The above examples and the drawings are intended to illustrate, but not limit the present invention, which is as defined in the claims. Numerous variations from the examples and drawings but still in accordance with the invention are possible. For example, the colors and pattern arrangements may be varied. Either the anterior or posterior surface of the lens or both may be printed. The opaque material may be on the lens surface or within the lens, or both. Furthermore, in lenses intended for wearers having lightly colored iris's, the opaque coloring may be merely translucent.

WHAT IS CLAIMED IS:

1. A colored contact lens comprising a non-opaque pupil section, an iris section surrounding said pupil section, and a colored, opaque intermittent pattern over said entire iris section, that leaves a substantial portion within the interstices of the pattern non-opaque, said pattern covering at least about 25 percent of the area of said iris section, the elements of said pattern being undiscernible to the ordinary viewer, wherein a first portion of the elements of said pattern are of a first shade and a second portion of the elements of said pattern are of a second shade different from said first shade, wherein said first portion is located generally on the outside of said iris section and said second portion is located generally on the inside of said iris section, and a jagged border separates said first and second portions, wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 5% to about 45% of the radial width of said iris section, and the maximum distance of said border from the outer perimeter of said iris section is from about 45% to about 95% of the radial width of said iris section, thereby providing a lens capable of changing the apparent color of the iris of a person wearing the lens and imparting a very natural appearance.

25

2. The lens of claim 1 wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 10% to about 30% of the radial width of said iris section, and the maximum distance of said border from the outer perimeter of said iris section is from about 60% to about 80% of the radial width of said iris section.

30

3. The lens of claim 1 or claim 2 wherein the elements of the pattern are dots.

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4. The lens of claim 3 wherein the non-opaque interstices are uncolored.

5 5. The lens of claim 3 wherein the non-opaque interstices are translucently colored.

6. A colored contact lens comprising a non-opaque pupil section, an opaque iris section surrounding said pupil section except for non-opaque elements in said iris section undiscernible to the ordinary viewer, wherein a first portion of said opaque iris section is of a first shade, and a second portion of said opaque iris section is of a second shade different from said first shade, said first portion is located generally on the outside of said iris section and said second portion is located generally on the inside of said iris section, and a jagged border separates said first and second portions, wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 5% to about 45% of the radial width of said iris section, and the maximum distance of said border from the outer perimeter of said iris section is from about 45% to about 95% of the radial width of said iris section, thereby providing a lens capable of changing the apparent color of the iris of a person wearing the lens and imparting a natural appearance.

7. The lens of claim 6 wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 10% to about 30% of the radial width of said iris section, and the maximum distance of said border from the outer perimeter of said iris section is from about 60% to about 80% of the radial width of said iris section.

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8. The lens of claim 7 wherein the non-opaque elements of said iris section are uncolored.

9. The lens of claim 7 wherein the non-opaque
5 elements of said iris section are translucently colored.

10. A colored contact lens comprising a non-opaque pupil section and an opaque iris section surrounding said pupil section, wherein a first portion of said iris section
10 is of a first shade, and a second portion of said iris section is of a second shade different from said first shade, said first portion is located generally on the outside of said iris section and said second portion is located generally on the inside of said iris section and a jagged border separates said first and
15 second portions, wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 5% to about 45% of the radial width of said iris section, and the maximum distance of said border from the outer
20 perimeter of said iris section is from about 45% to about 95% of the radial width of said iris section, thereby providing a lens capable of changing the apparent color of the iris of a person wearing the lens and imparting a natural appearance.

11. The lens of claim 10 wherein the minimum
25 distance of said jagged border from the outer perimeter of said iris section is from about 10% to about 30% of the radial width of said iris section, and the maximum distance of said jagged border from the outer perimeter of said iris section is from about 60% to about 80% of the radial width of said iris
30 section.

12. A colored contact lens comprising a non-opaque pupil section and an iris section surrounding said pupil
s ction, said iris section comprising a first outer portion and

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a second inner portion separated by a jagged border wherein the minimum distance of said jagged border from the outer perimeter of said iris section is from about 5% to about 45% of the radial width of said iris section and the maximum distance of said border from the outer perimeter of said iris section is from about 45% to about 95% of the radial width of said iris section, wherein one of said portions is non-opaque and the other portion has opaque coloring.

10 13. The lens of claim 12 wherein the opaque coloring is a pattern comprised of elements that are undiscernable to the ordinary viewer.

15 14. A colored contact lens comprising a non-opaque pupil section and an iris section surrounding said pupil section, said iris section comprising a first outer portion surrounding a second intermediate portion and a third inner portion surrounded by said intermediate portion, said first and second portions separated by a first jagged border and said 20 second and third portions separated by a second jagged border, wherein either said first and third portions have opaque coloring and said second portion is non-opaque, or said second portion has opaque coloring and said first and third portions are non-opaque, or said first, second and third portions have 25 opaque coloring and said second portion has a different shade than said first and second portions.

15 15. The lens of claim 14 wherein the opaque coloring is a pattern comprised of elements that are 30 undiscernable to the ordinary viewer.

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FIG. 1

(PRIOR ART)

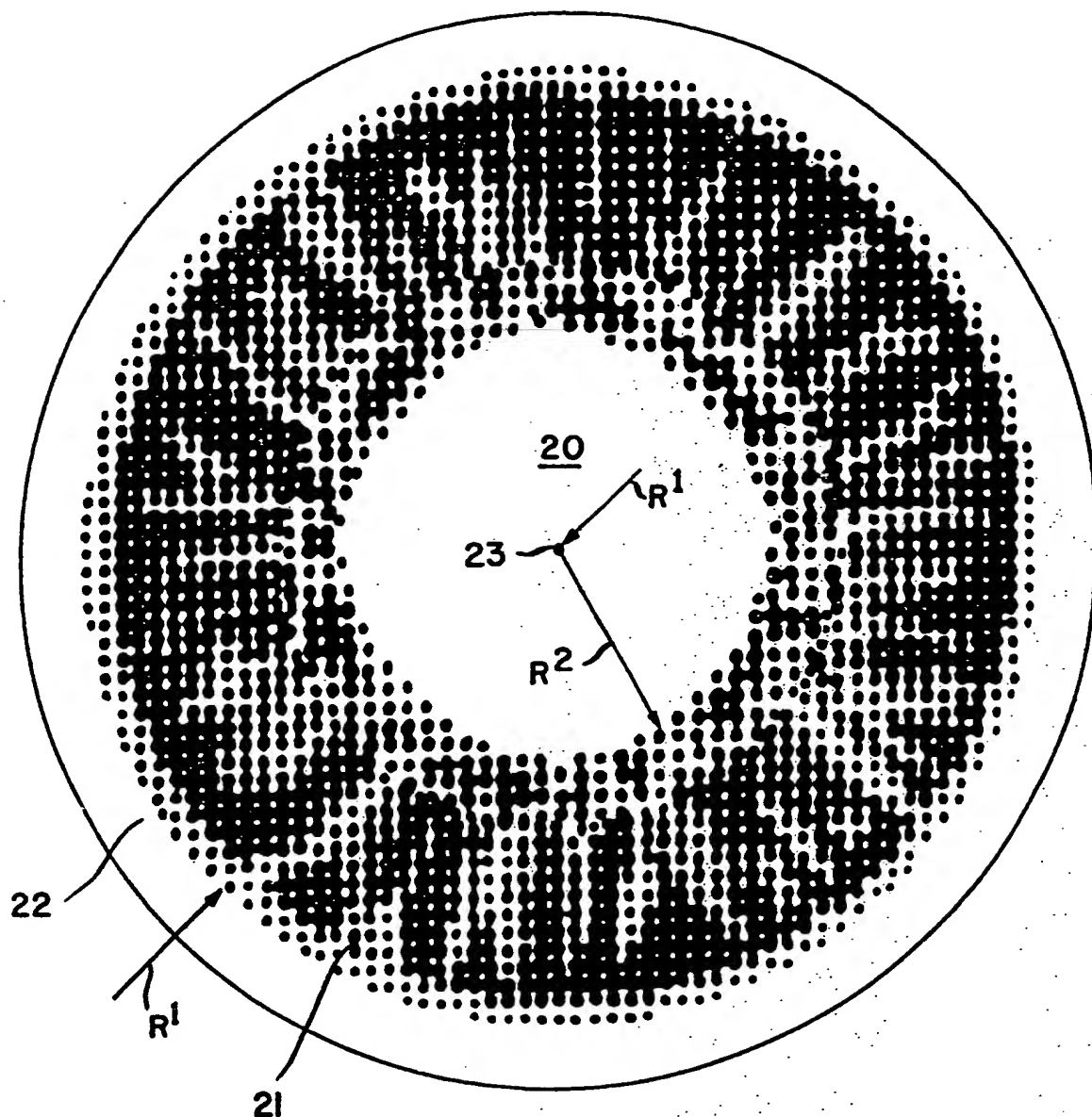
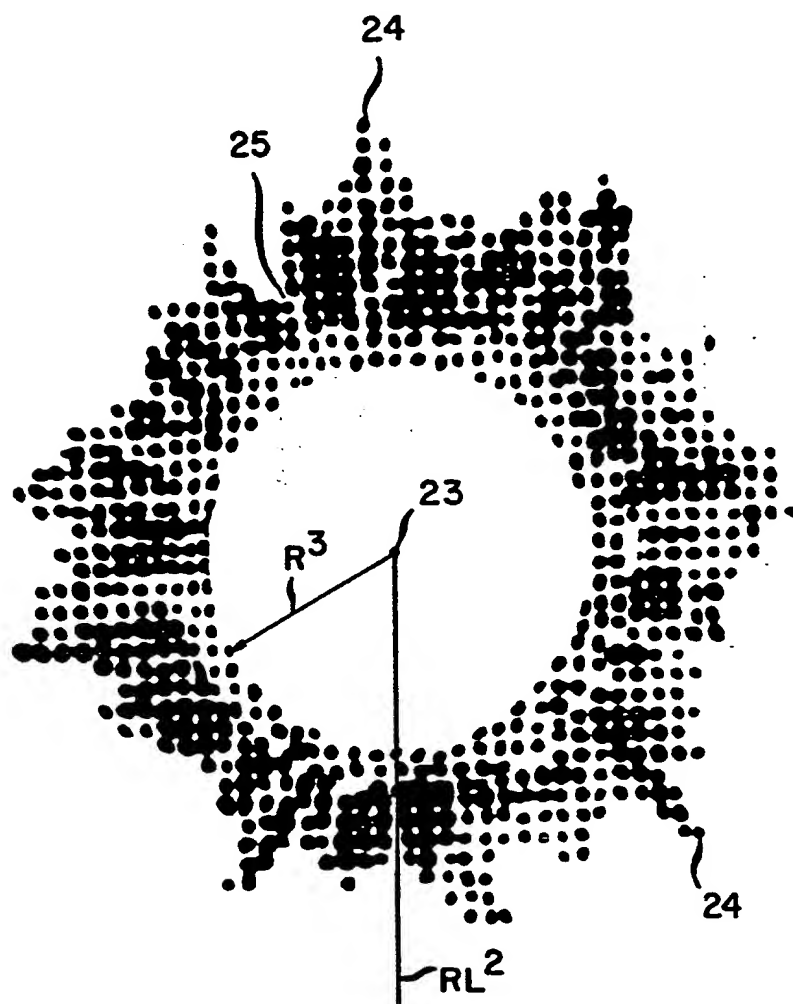
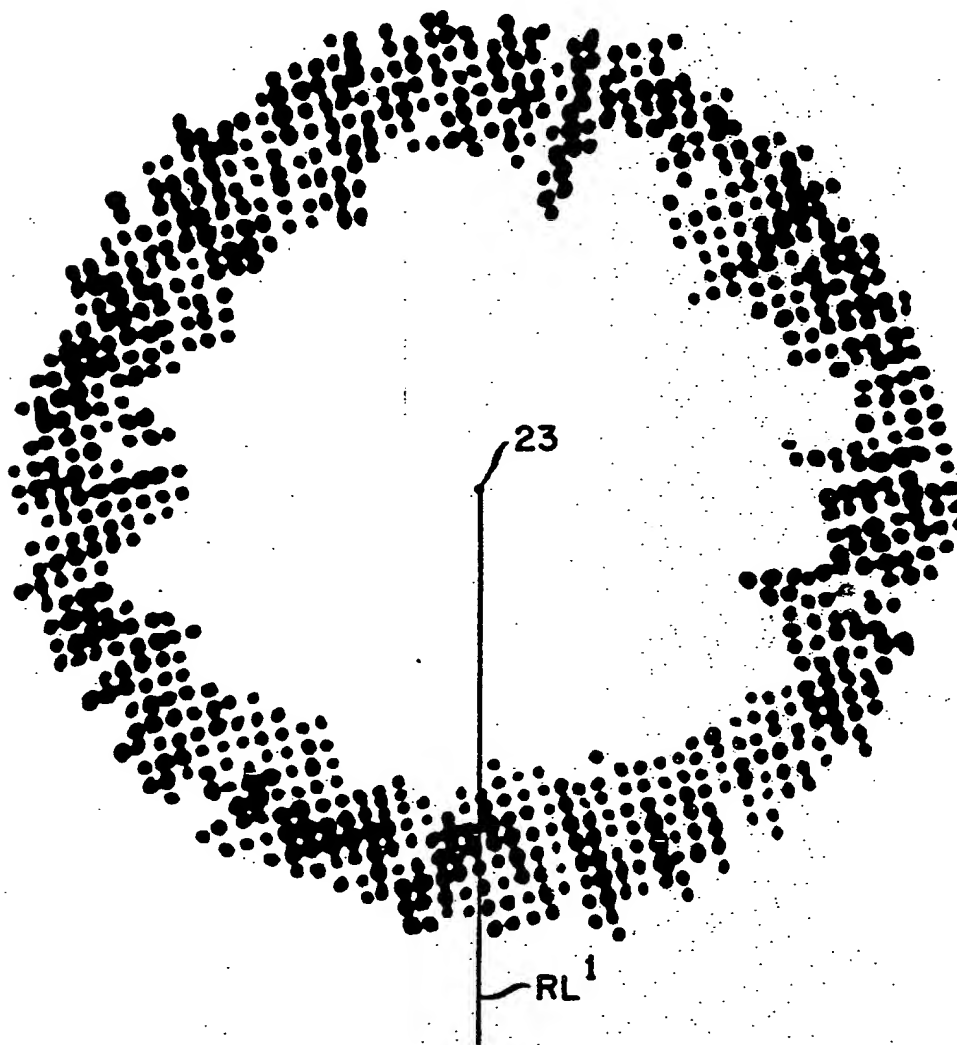


FIG. 2



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FIG. 3



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FIG. 4

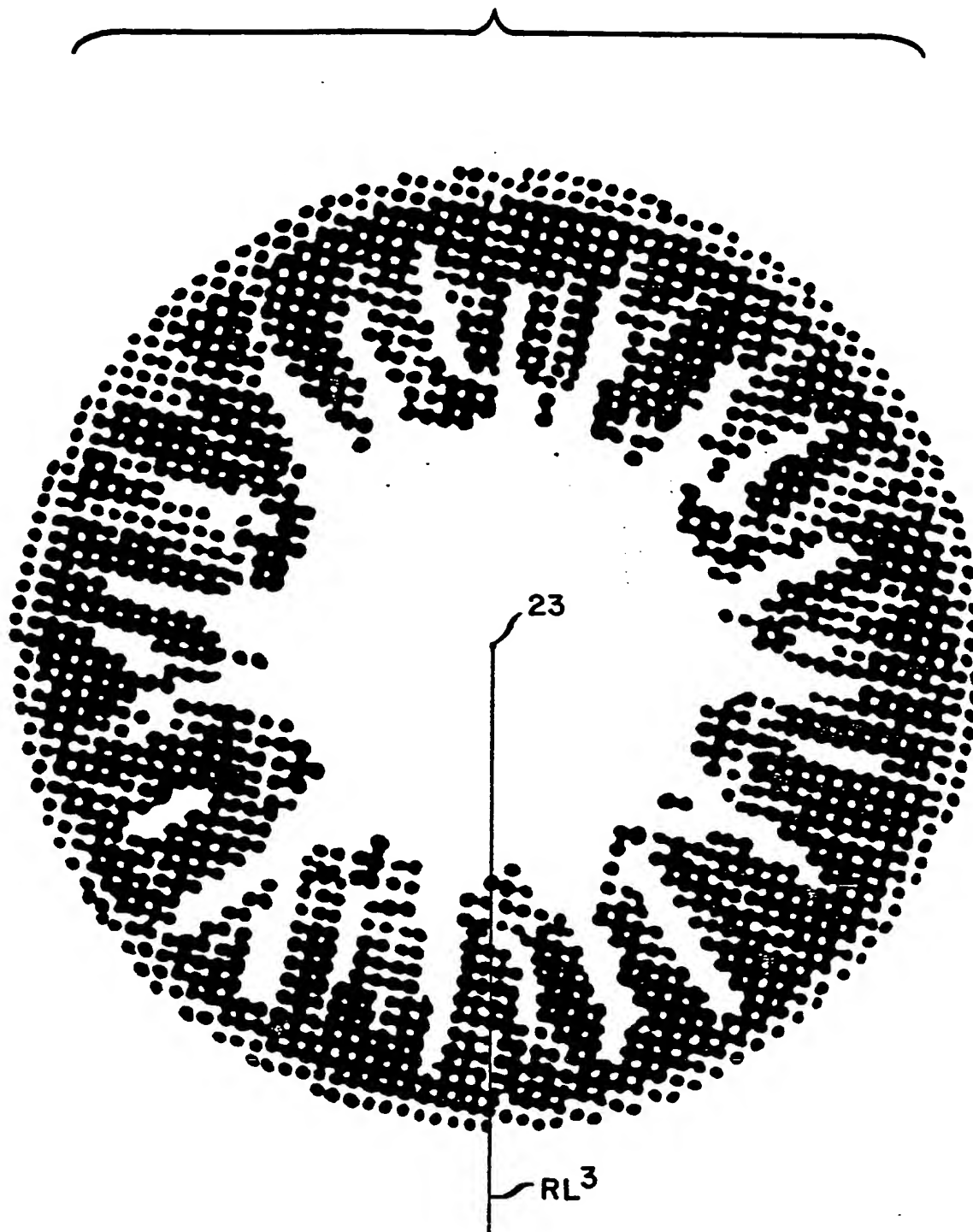


FIG. 5

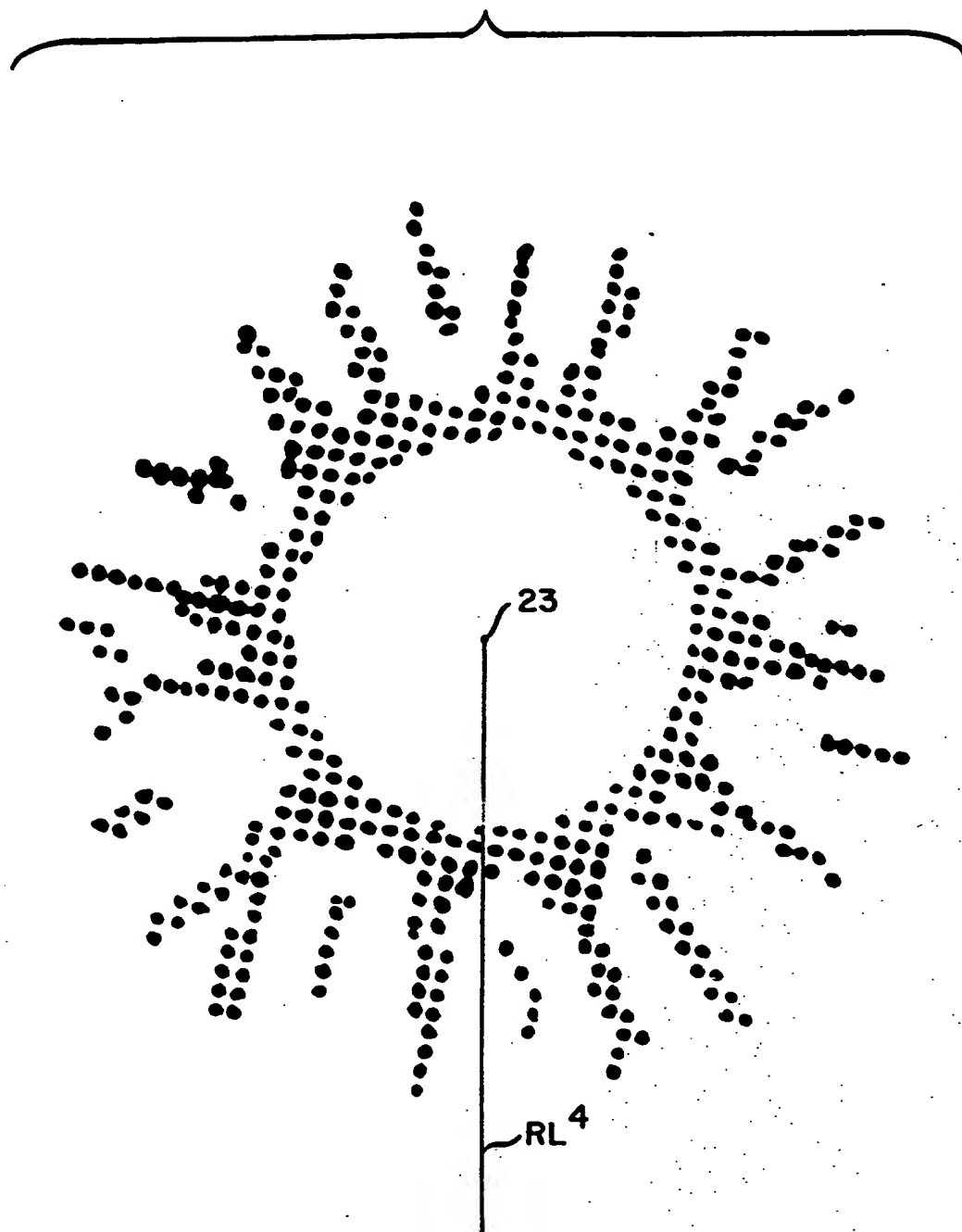
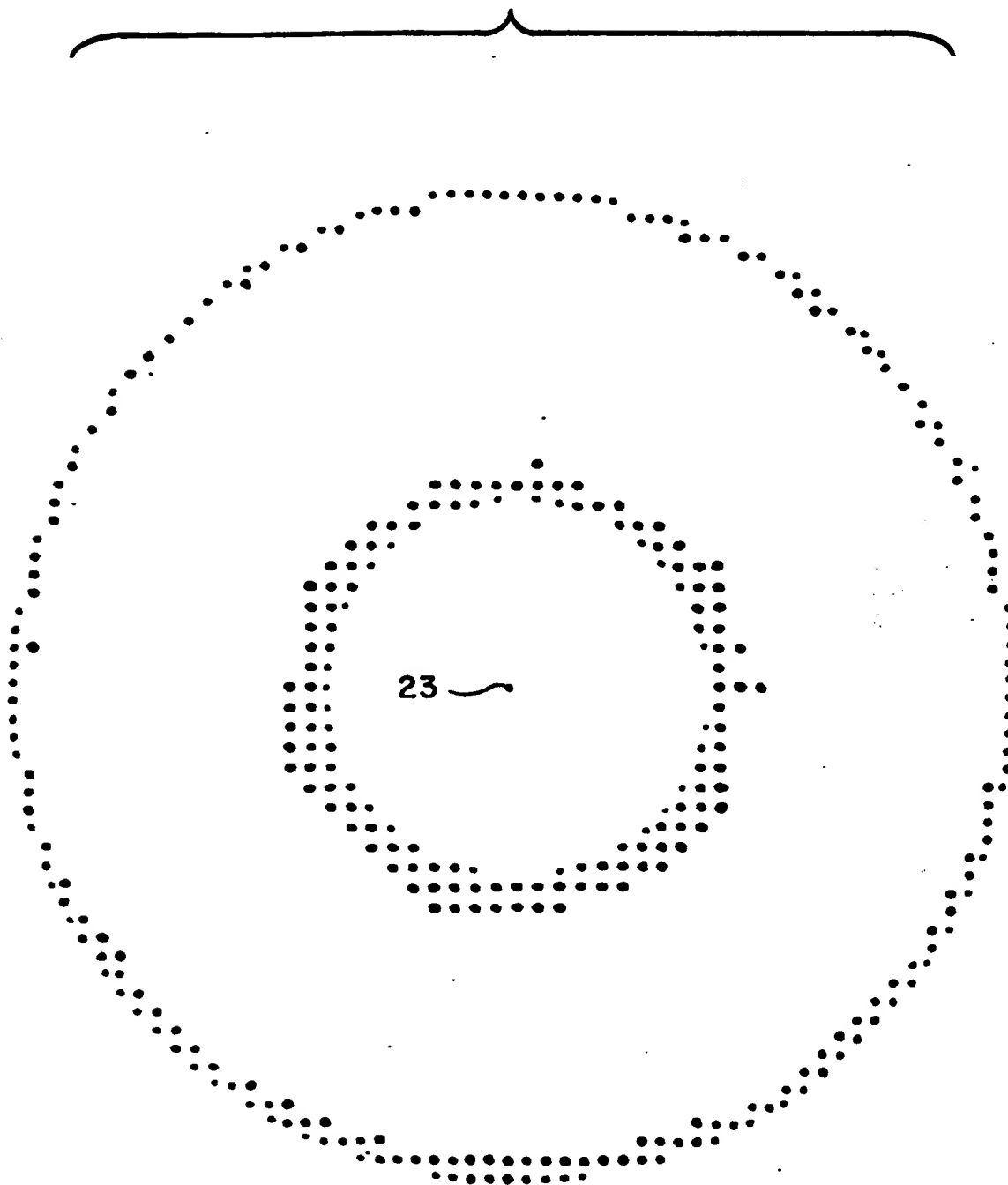
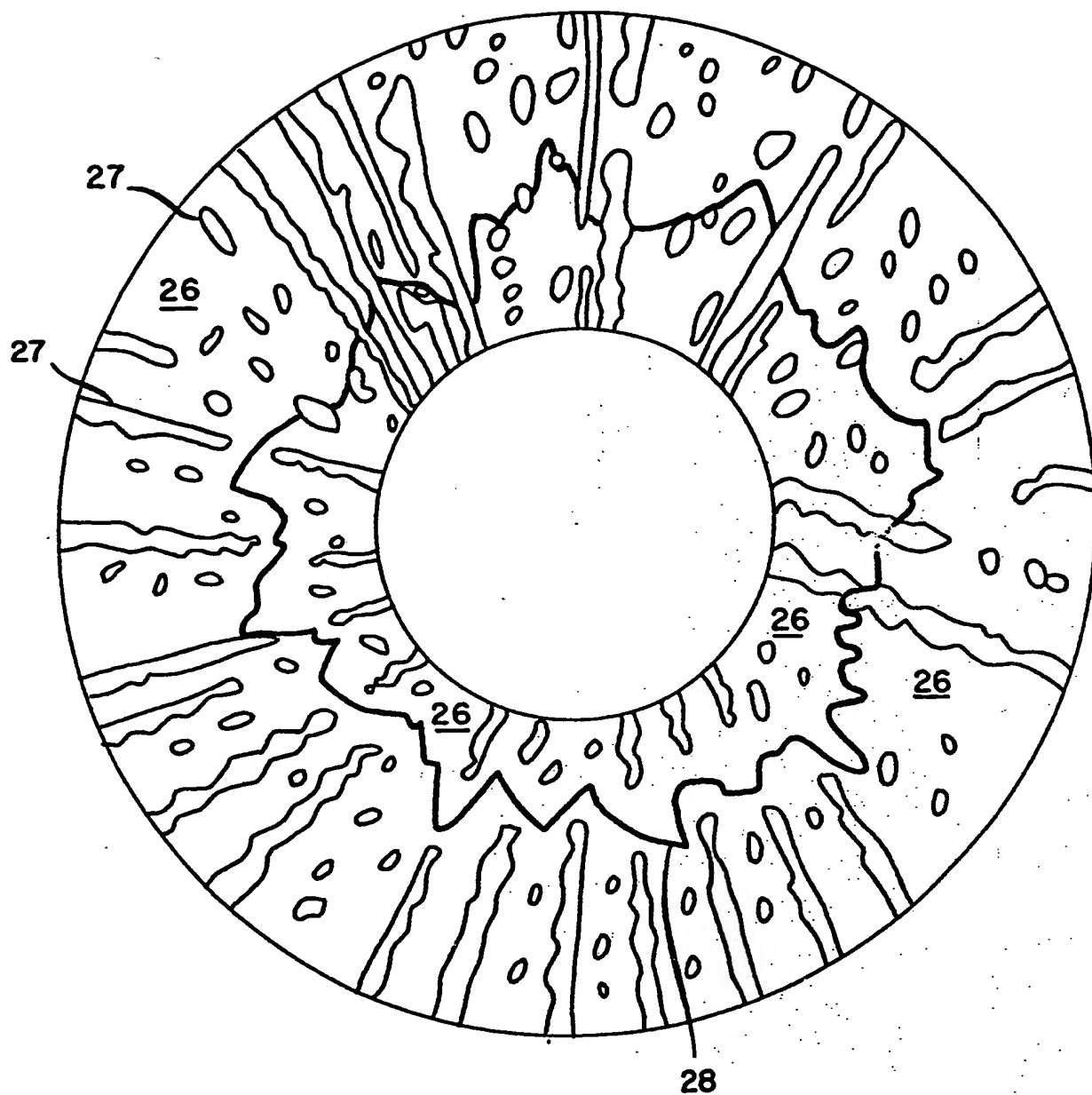


FIG. 6



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FIG. 7



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FIG. 8

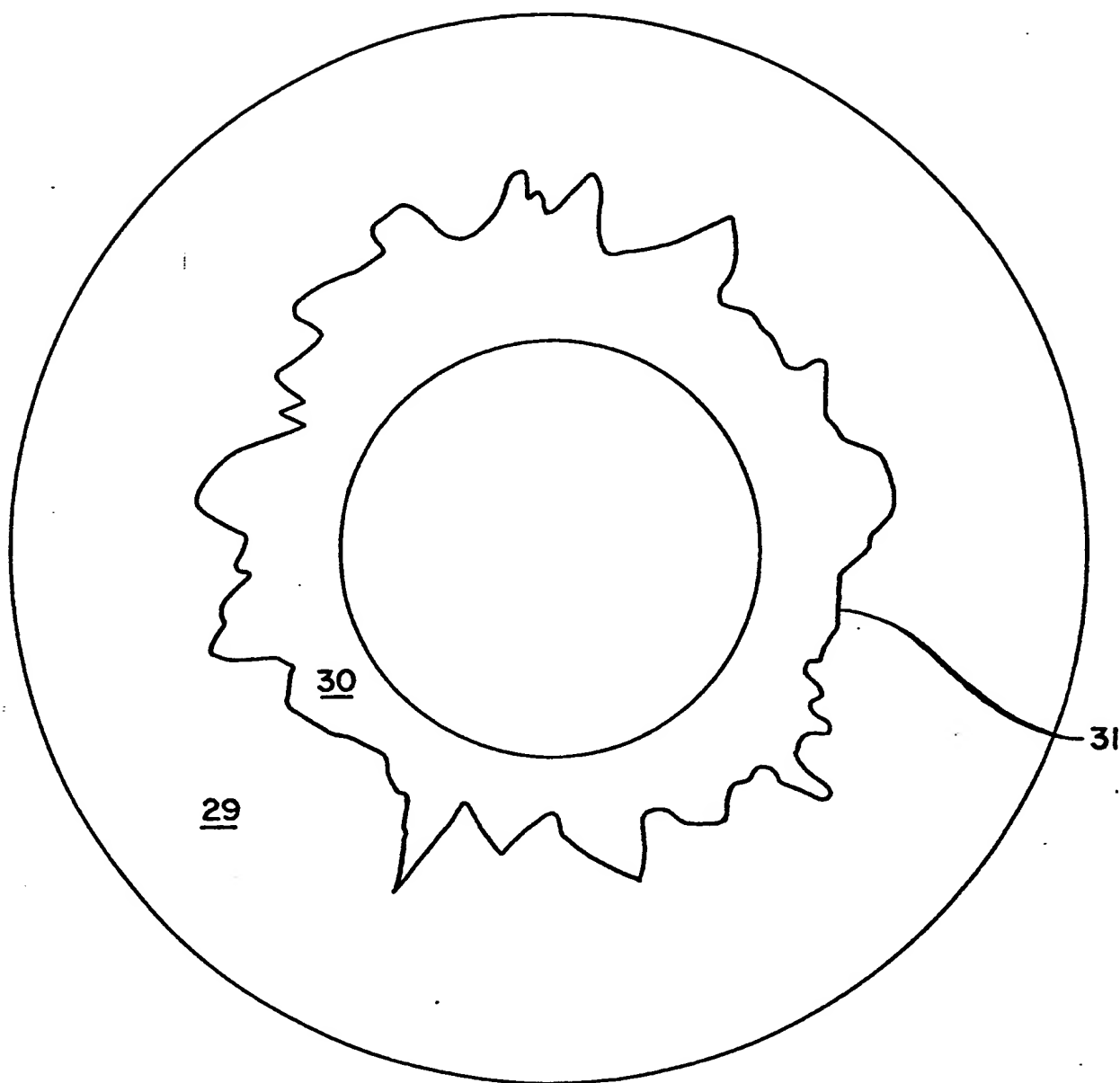
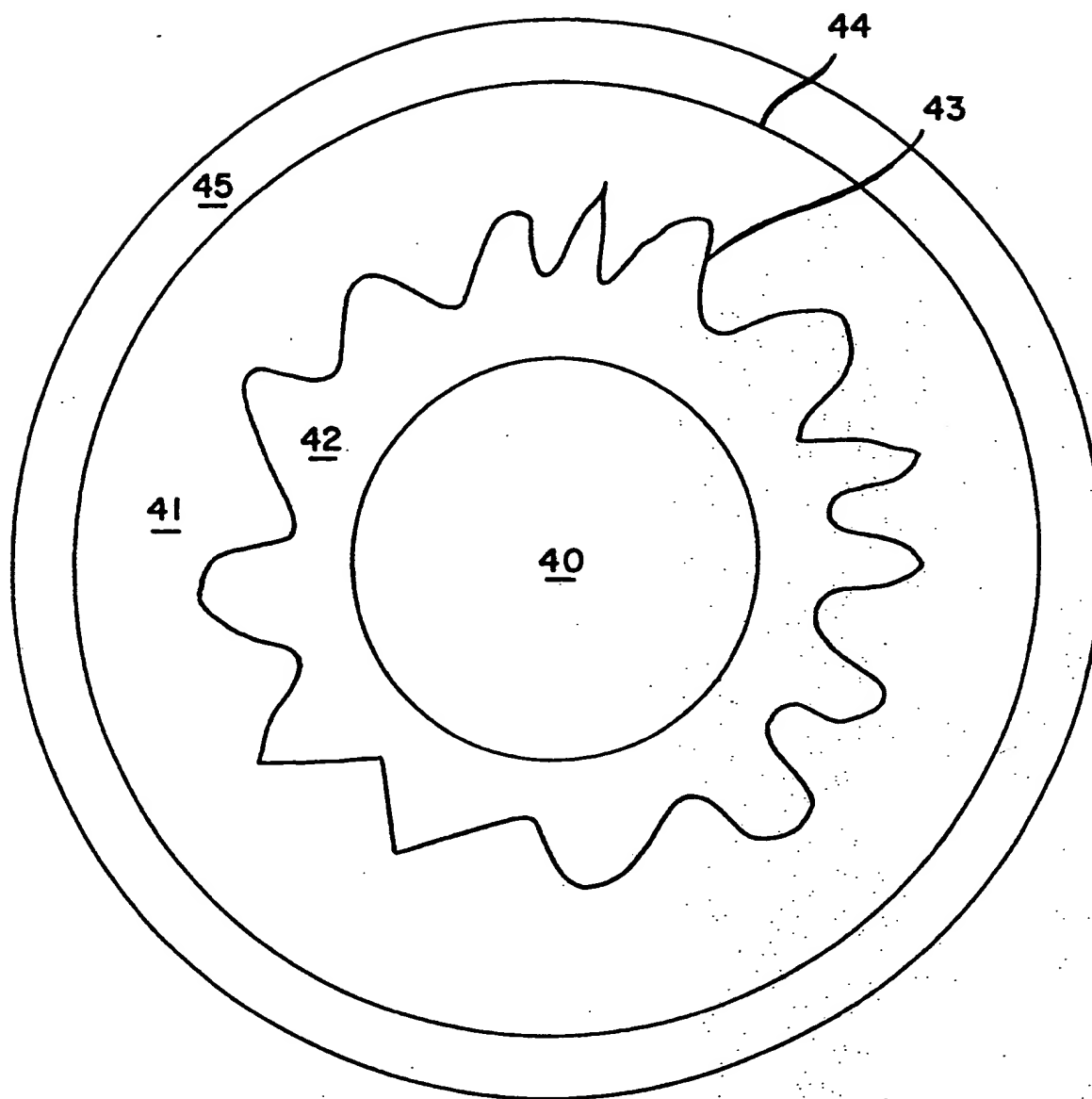
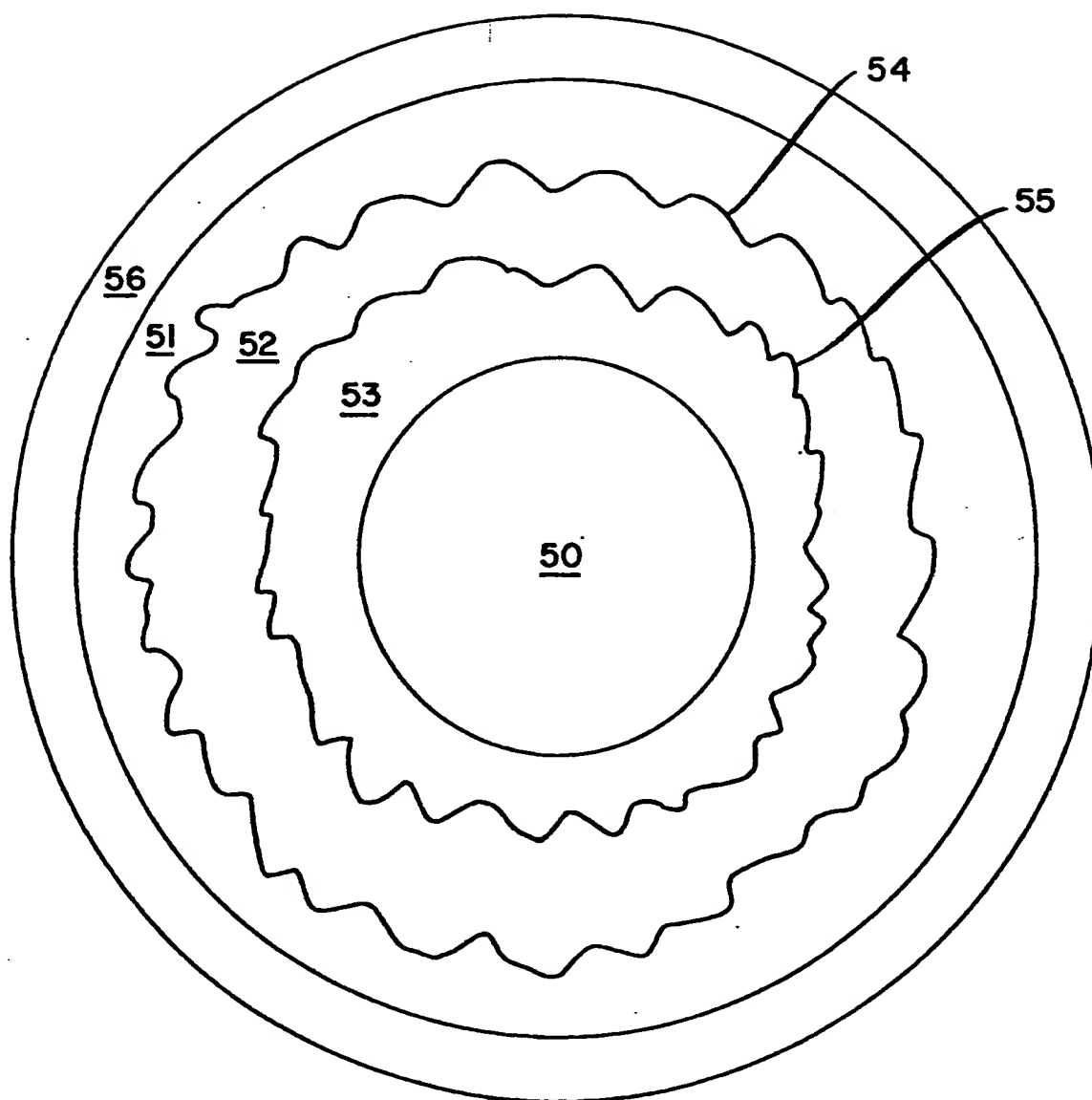


FIG. 9



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FIG. 10



INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 90/06144

| CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶ according to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁵ : G 02 C 7/04, G 02 C 7/02 | | | | | | | | | | | | | | | | | | | | |
|---|--|-------------------------------------|---|--|--|--|---|---|---|--|---|---|---|---|---|--|---|-----|--|--|
| II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; text-align: left; border-bottom: 1px solid black;">Classification System</th> <th style="width: 75%; text-align: left; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">IPC⁵</td> <td style="padding: 5px;">G 02 C 7/04, G 02 C 7/02</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched⁸</div> | | | Classification System | Classification Symbols | IPC ⁵ | G 02 C 7/04, G 02 C 7/02 | | | | | | | | | | | | | | |
| Classification System | Classification Symbols | | | | | | | | | | | | | | | | | | | |
| IPC ⁵ | G 02 C 7/04, G 02 C 7/02 | | | | | | | | | | | | | | | | | | | |
| III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; text-align: left; padding: 5px;">Category¹⁰</th> <th style="width: 60%; text-align: left; padding: 5px;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 30%; text-align: left; padding: 5px;">Relevant to Claim No. ¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;"> US, A, 3712718 (J.A. LE GRAND) 23 January 1973 see abstract; claims cited in the application <div style="text-align: center;">---</div> </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;"> EP, A, 0158999 (SCHERING CORPORATION) 23 October 1985 see abstract; claims cited in the application <div style="text-align: center;">---</div> </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;"> US, A, 3536386 (M. SPIVACK) 27 October 1970 see columns 1,2 cited in the application <div style="text-align: center;">---</div> </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;"> WO, A, 85/04679 (BARNES-HIND) 24 October 1985 see abstract; claims <div style="text-align: center;">---</div> </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td colspan="2" style="text-align: right; padding: 5px;">./.</td> <td></td> </tr> </tbody> </table> | | | Category ¹⁰ | Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹² | Relevant to Claim No. ¹³ | A | US, A, 3712718 (J.A. LE GRAND) 23 January 1973 see abstract; claims cited in the application <div style="text-align: center;">---</div> | 1 | A | EP, A, 0158999 (SCHERING CORPORATION) 23 October 1985 see abstract; claims cited in the application <div style="text-align: center;">---</div> | 1 | A | US, A, 3536386 (M. SPIVACK) 27 October 1970 see columns 1,2 cited in the application <div style="text-align: center;">---</div> | 1 | A | WO, A, 85/04679 (BARNES-HIND) 24 October 1985 see abstract; claims <div style="text-align: center;">---</div> | 1 | ./. | | |
| Category ¹⁰ | Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹² | Relevant to Claim No. ¹³ | | | | | | | | | | | | | | | | | | |
| A | US, A, 3712718 (J.A. LE GRAND) 23 January 1973 see abstract; claims cited in the application <div style="text-align: center;">---</div> | 1 | | | | | | | | | | | | | | | | | | |
| A | EP, A, 0158999 (SCHERING CORPORATION) 23 October 1985 see abstract; claims cited in the application <div style="text-align: center;">---</div> | 1 | | | | | | | | | | | | | | | | | | |
| A | US, A, 3536386 (M. SPIVACK) 27 October 1970 see columns 1,2 cited in the application <div style="text-align: center;">---</div> | 1 | | | | | | | | | | | | | | | | | | |
| A | WO, A, 85/04679 (BARNES-HIND) 24 October 1985 see abstract; claims <div style="text-align: center;">---</div> | 1 | | | | | | | | | | | | | | | | | | |
| ./. | | | | | | | | | | | | | | | | | | | | |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>¹⁰ Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div> | | | | | | | | | | | | | | | | | | | | |
| IV. CERTIFICATION <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;"> Date of the Actual Completion of the International Search <div style="text-align: center; padding: 5px;">22nd January 1991</div> </td> <td style="width: 50%; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center; padding: 5px;">11. 02. 91</div> </td> </tr> <tr> <td style="width: 50%; padding: 5px;"> International Searching Authority <div style="text-align: center; padding: 5px;">EUROPEAN PATENT OFFICE</div> </td> <td style="width: 50%; padding: 5px;"> Signature of Authorized Officer <div style="text-align: center; padding: 5px;"> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">M. PEIS</div> M. Peis </div> </td> </tr> </table> | | | Date of the Actual Completion of the International Search <div style="text-align: center; padding: 5px;">22nd January 1991</div> | Date of Mailing of this International Search Report <div style="text-align: center; padding: 5px;">11. 02. 91</div> | International Searching Authority <div style="text-align: center; padding: 5px;">EUROPEAN PATENT OFFICE</div> | Signature of Authorized Officer <div style="text-align: center; padding: 5px;"> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">M. PEIS</div> M. Peis </div> | | | | | | | | | | | | | | |
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| International Searching Authority <div style="text-align: center; padding: 5px;">EUROPEAN PATENT OFFICE</div> | Signature of Authorized Officer <div style="text-align: center; padding: 5px;"> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">M. PEIS</div> M. Peis </div> | | | | | | | | | | | | | | | | | | | |

| III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET) | | |
|--|--|-----------------------|
| Category * | Citation of Document, " with indication, where appropriate, of the relevant passages | Relevant to Claim No. |
| A | FR, A, 2074870 (THE PLASTIC CONTACT LENS COMP.) 8 October 1971 see claims --- | 1 |
| A | EP, A, 0262832 (MED OPTICS CORP.) 6 April 1988 see abstract; claims --- | 1 |
| A | EP, A, 0309154 (ALLERGAN INC.) 29 March 1989 see claims cited in the application ----- | 1 |

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

US 9006144
SA 41774

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/02/91. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---------------------|--|--|
| US-A- 3712718 | 23-01-73 | None | |
| EP-A- 0158999 | 23-10-85 | US-A- 4582402 CA-A- 1255521 JP-A, B 60235115 US-A- 4720188 US-A- 4704017 | 15-04-86 13-06-89 21-11-85 19-01-88 03-11-87 |
| US-A- 3536386 | 27-10-70 | None | |
| WO-A- 8504679 | 24-10-85 | AU-A- 4219085 EP-A- 0177606 | 01-11-85 16-04-86 |
| FR-A- 2074870 | 08-10-71 | CA-A- 948451 DE-A- 2063175 GB-A- 1340877 | 04-06-74 29-07-71 19-12-73 |
| EP-A- 0262832 | 06-04-88 | AU-B- 588131 AU-A- 7842687 US-A- 4811662 US-A- 4872405 ZA-A- 8706883 | 07-09-89 24-03-88 14-03-89 10-10-89 17-03-88 |
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